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Item 6 of the provisional agenda*
Space debris

Research on space debris, the safety of space objects with nuclear power sources on board and problems relating to their collision with space debris

Note by the Secretariat

I. Introduction

1. At its sixtieth session, the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space agreed that Member States and international organizations having permanent observer status with the Committee should continue to be invited to provide reports on research on space debris, the safety of space objects with nuclear power sources on board, problems relating to the collision of such space objects with space debris and the ways in which debris mitigation guidelines were being implemented (A/AC.105/1279, para. 99). Accordingly, a communication dated 16 August 2023 was sent to Member States and international organizations having permanent observer status, inviting them to provide their reports by 20 October 2023 so that the information contained in them could be made available to the Subcommittee at its sixty-first session.

2. The present document has been prepared by the Secretariat on the basis of information received from seven Member States, namely, Algeria, Austria, Germany, Japan, Myanmar, Slovakia and the United Arab Emirates. Further information provided by Japan, including figures related to space debris, will be made available as a conference room paper at the sixty-first session of the Subcommittee.

* A/AC.105/C.1/L.412.

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II. Replies received from Member States

Algeria

[Original: French]
[18 October 2023]

Algeria, which attaches particular importance to these issues, welcomes the work of the Office for Outer Space Affairs to promote international collaboration and foster progress in this area and reiterates its support for the efforts of the international community to mitigate space debris and protect the orbital and suborbital environments.

With regard to the safety of space objects with nuclear power sources on board, Algeria participates actively in the work of the Committee on the Peaceful Uses of Outer Space and its two subsidiary bodies and supports the objectives of the five-year plan established by the Working Group on the Use of Nuclear Power Sources in Outer Space, endorsed at the Committee's sixty-sixth session.

Our country considers that States should pay greater attention to the possible consequences of the use of such power sources in outer space, which would undermine any form of long-term sustainability of outer space activities and the preservation of space as the common heritage of humankind for future generations.

In that regard, it recalls the provisions of article IV of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, which stipulates that States parties to the Treaty undertake not to place in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner.

Austria

[Original: English]
[18 October 2023]

Besides performing routine range measurements of active satellites equipped with corner cube retroreflectors, the satellite laser ranging station of the Space Research Institute of the Austrian Academy of Sciences is currently involved in several activities related to space safety. The design and assembly of backup retroreflectors for use in future satellite missions will play a crucial role in attitude determination and future removal missions. The Space Research Institute is developing a tool to simulate satellite laser ranging residuals while varying orbit, tumbling or corner cube retroreflector configuration. In addition, determination of tumbling and attitude motion is made by analysing single photon light curves, which display the reflected sunlight from satellites or space debris objects. A large database was built that characterizes and measures more than 20 different space debris objects. The combination of different techniques (for example, light curves, satellite laser ranging, space debris laser ranging and imaging radar) is also investigated and is referred to as "data fusion". The Institute is currently upgrading the satellite laser ranging station on Teide, Tenerife, to provide space debris laser ranging capabilities. A new design concept for a space debris laser expansion telescope is being developed, assembled and tested. The new station will operate in a unique design building – a stand-alone dome solely for space debris laser expansion optics. The set-up will be operating routinely in a bi-static mode together with the receiving telescope of the original satellite laser ranging station. Further information on the satellite laser ranging station is available at www.oeaw.ac.at/en/iwf/research/research-groups/satellite-laser-ranging.

Germany

[Original: English]
[20 October 2023]

Research activities on issues related to space debris are conducted in Germany in all relevant fields. This includes space debris environment modelling, observation of space debris, technology development for observations, studies of the effects of hypervelocity impact on spacecraft, protection of space systems from the impact of micrometeoroids and space debris, as well as design for demise technologies. German experts actively participate in relevant international forums in the field of space debris research and space safety, inter alia, the Inter-Agency Space Debris Coordination Committee and the International Academy of Astronautics, in international standardization activities in the field of space debris, and in aspects of space traffic coordination. German industry and academia are also involved in technology developments to serve the long-term sustainable use of outer space and the protection of the Earth.

The dialogue with the small-satellite initiative of German universities and with other national and European stakeholders (which was reported on in last year's contribution) is continuing. The aim of that dialogue is to maintain a high level of sustainability for the fast-growing space activities at universities and in small and medium-sized enterprises and to support the sharing of knowledge and best practices. The German Space Agency provides support to ongoing projects, has offered online expert workshops related to space debris mitigation topics and has participated in conferences.

Measurements

The development of capabilities for generating and utilizing sensor data is needed to establish a national space surveillance competence, for instance, to generate a space object catalogue and to perform orbit determination. Such an object catalogue is the backbone of space situational awareness operations. Therefore, the German Space Agency, through its national programme with funding from the German Federal Ministry for Economic Affairs and Climate Action, initiated the development of the German Experimental Space Surveillance and Tracking Radar (GESTRA). The system was developed by the Fraunhofer Institute for High Frequency Physics and Radar Techniques. It is an experimental system to survey and determine the orbital information of resident space objects in low Earth orbit. The system is currently being used to perform further test and verification activities. The system can be operated fully remotely by the German Space Situational Awareness Centre (GSSAC). GESTRA is also intended to serve as an experimental platform for bi- and multi-static radar operations and to provide data to research institutions in Germany to conduct further studies in that area.

A central database has been developed, hosted and operated by GSSAC since 2019 for the collection and sharing of measurements from the European Union Space Surveillance and Tracking (EU SST) consortium, serving as the main data-sharing platform for EU SST. As a second step, the development of a European precursor catalogue based on that database is ongoing.

Multiple options have been identified to increase the performance of ground-based surveillance radar measurements of space debris. A promising option is the use of multiple surveillance radars at separate sites working in bi- and multi-static configurations. Such a network of radars is expected not only to increase the size of a surveillance area, but also to result in better measurements of single objects. A study to further analyse such operation modes is currently being conducted through a collaboration between two Fraunhofer institutes. A simulation framework has been developed that enables the modelling of various configurations of multi-static surveillance radar systems. A first radar receiver for such a network of radar systems is under development.

An international network of optical telescopes called the Small-Aperture Robotic Telescope Network (SMARTnet) began operating in 2017 and currently consists of six sites with a total of 12 telescopes. Those stations are located in Switzerland, Spain, Slovenia, South Africa and Australia, with the German Aerospace Center (DLR) operating the ones in South Africa and Australia. A third DLR station is planned to be deployed in Chile in January 2024. The network is organized by DLR in close cooperation with the Astronomical Institute of the University of Bern, Switzerland, and is open to the public. The network utilizes telescopes with apertures ranging from 20 cm to 80 cm to observe the geostationary region and related orbits in order to support research on collision avoidance and other scientific topics, encompassing data for objects larger than approximately 30 cm in geosynchronous orbits.

DLR is also developing an information system with the Backbone Catalogue of Relational Debris Information, an orbital database for objects in Earth orbit, which is central to this project. Key functionalities, such as object correlation using observations from different sensors (radar, optical and satellite laser ranging), providing the first observational data to be processed by the system, orbit determination and orbit propagation, are currently fully operational. A graph clustering algorithm is applied for detecting new resident space objects. The different input data can be fused and combined for objects to produce a better orbit determination solution. Furthermore, a complete screening algorithm to detect close approaches between objects is in development. All algorithms are programmed such that observation data for up to 100,000 objects can be processed in real time. Currently ongoing research topics include manoeuvre detection and deriving optimum planning from the database for sensors to keep all objects within a specified accuracy.

A large Ritchey-Chrétien telescope with a diameter of 1.75 m for the observation and analysis of small space debris objects a few centimetres in size has been installed by DLR in southern Germany, at the Johannes Kepler observatory, and started operating in 2023. The telescope is equipped with four Nasmyth foci and a Coudé path. In addition, it can be used as a laser transmitter or photon receiver participating in bi-static laser ranging campaigns, using transportable containerized laser transmitters. In general, the telescope serves as a research platform for developing new and innovative laser optical technologies for space safety applications for all Earth orbits, including the very low Earth orbit altitude range. In addition to the implementation of active laser optical technologies, the passive optical spectral analysis of orbital objects will be carried out. The observatory will be used for high-resolution dynamic light curve measurements of debris objects, primarily in the visible and near infrared spectral range, to assess the rotational status and changes thereof, in preparation for and to mitigate the risks associated with upcoming robotic removal missions. In addition, fundamental research on very low Earth orbits will be carried out at the observatory together with the University of Stuttgart, within a collaborative research centre of the German Research Foundation (DFG). Here, DLR will develop a novel laser ranging method to determine the range and attitude of objects in very low Earth orbit.

A very compact, automatically operated satellite laser ranging system (miniSLR) had been developed by DLR. The system provides laser ranging precision down to a few centimetres in the positional data, from satellites in low Earth orbit and medium Earth orbit that are equipped with retroreflectors. Such data have numerous applications in geodesy, Earth observation, satellite operation and the monitoring of decommissioned satellites. A corresponding in-orbit component based on an athermal ceramic retroreflector design has been developed and can be utilized by satellite operators as a solution for laser-based tracking. In addition, the use of new passive polarimetric distinguishable retroreflectors allows for the tagging of satellites, which is useful, for example, in the case of cluster launches of small satellites and within satellite constellations. The miniSLR laser optical ground station is adapted as a specific laser transmitter for the polarimetric retroreflector payload components. DLR is preparing demonstrations of satellite laser ranging tagging technology in upcoming CubeSat missions. In general, corner cube retroreflectors as adapted orbital components

for the miniSLR ground station technology will enable a transfer of laser ranging and precise orbit determination to non-geodetic satellites and contribute to the sustainable use of densely populated orbits.

Modelling and on-orbit and on-ground risk assessment

The primary goal of a new project at the Technical University of Braunschweig is to enhance and update existing models that describe the creation of space debris using newly acquired data. The project places particular emphasis on refining and improving the model that explains the process of fragmentation, which includes both explosions and collisions in space. These events are of utmost concern because of their potential to have severe consequences for the safe functioning of both satellites and crewed missions, especially in low Earth orbit. Accurately modelling the quantity, size and spatial-temporal evolution of debris resulting from fragmentation events is essential for assessing collision risks. This assessment extends beyond just operational satellites, encompassing all objects in orbit. Consequently, it plays a crucial role in ensuring the overall safety and long-term stability of the Earth's orbital environment.

Further ongoing research is centred around the development, characterization and synthesis of various criticality metrics. These metrics are essential for evaluating the condition of the space debris environment. The ultimate objective is to create a metric capable of assessing the influence of individual objects on the overall environment, pinpointing areas of particular concern, and of monitoring the overall health of the environment. In addition, tools used to simulate potential future scenarios in the space debris environment are continuously enhanced. Those updates encompass new modelling techniques and databases, with a particular focus on addressing the unique challenges posed by large constellations.

Germany continues to develop advanced numerical methods for the simulation of break-up events of space systems at large scale. Recent research performed at the Fraunhofer Institute for High-Speed Dynamics, Ernst Mach Institute demonstrated the feasibility of reproducing the effects of hypervelocity impact-induced fragmentation for various materials using a discrete element method approach. The ability to seamlessly capture a material's transition from a solid state to a fragmented state is central to investigating space debris generation in complex impact scenarios. Specifically, these events involve the break-up of satellites and upper stages owing to explosions or collisions, which cannot be investigated through ground testing. While hypervelocity fragmentation determines the failure process, the full characterization of large-scale break-ups also requires a realistic simulation of deformations and material effects such as yield and plasticity. This is the objective of a new project, which is aimed at coupling the developed discrete element code with methods well-suited to simulating continuous material behaviour. The overall goal is to provide an efficient tool for simulating satellites under catastrophic break-up and study the consequences for the orbit environment.

The German Space Operations Center (GSOC) has continued to further develop, maintain and operate a software system for conjunction assessment of spacecraft developed by GSOC in 2009. Besides conjunction assessment, the GSOC collision avoidance system (COLA) also features collision avoidance manoeuvre planning and generation of collision avoidance products. GSOC supports other entities in conjunction assessment and collision avoidance. It shares satellite ephemeris data with conjunction service providers such as EU SST, the Space Data Association and the 18th Space Defense Squadron of the United States Space Force, and actively contacts other satellite operators in order to harmonize collision avoidance measures where needed. Furthermore, GSOC is developing the software system Ascent Safety (ASSET). This software assesses the safety of launching trajectories and payload injection orbits for ground-, maritime- and air-based launches. To do this, the pre-flight trajectories and associated uncertainties are assessed throughout the entire launch windows, and individual and accumulated collision risks with resident space objects are computed. As a result, the collision criticality evolution over launch window spaces is provided as a decision-making aid for the launch segment.

Mission concepts and related technologies to increase sustainability in Earth orbit

DLR initiated an orbital sustainability impulse project (project ION) to bring together competencies from the fields of space, security and aeronautics, in particular with regard to satellite operations, robotics and automation, space debris observation and measurement, space weather, and aeronautical maintenance and repair in the aerospace sector.

Relevant technologies to address concepts and technologies to increase sustainability in Earth orbit throughout the life cycle of satellites and orbital infrastructure will be further analysed, and are currently being funded by the German Space Agency. The development of new satellite concepts, manufacturing processes and operating scenarios is intended to pave the way from the "disposable satellites" of today to a more performant and sustainable infrastructure in Earth orbit, which can also serve as a springboard for missions to our neighbouring planets. These technologies serve applications such as:

(a) Short term: space debris removal, life extension, inspection;

(b) Medium term: repair, payload retrofit, on-site assembly;

(c) Long-term: manufacturing, recycling, orbital depots.

Automation and robotics are key technologies for increasing the autonomy of space vehicles, including by means of artificial intelligence processes, and for enabling the receipt or provision of robotic services in orbit, such as maintenance, production or reconfiguration.

One of the main aims of these technologies is to prepare the necessary functionalities for a mission scenario to be defined. This mission scenario will essentially involve the task of approaching and capturing a target satellite.

Another important goal is to improve the interplay between the technologies for detecting, tracking and evaluating space debris on the ground, and for approaching and capturing a target object. New developments in space debris detection and analysis will give rise to new techniques that will be able to provide information on the rotation rate and direction of rotation of the target, in order to assist guidance, navigation and control and robotic systems in efficiently capturing the target in orbit.

Japan

[Original: English]
[20 October 2023]

Overview

The present report outlines the debris-related activities mainly conducted by the Japan Aerospace Exploration Agency (JAXA), in response to the request received from the Secretariat. As at October 2023, the following debris-related research and development activities are being undertaken.

(a) Active debris removal;

(b) Debris avoidance manoeuvres and research on space situational awareness technology;

(c) Research on technology to observe objects in low Earth orbit and geostationary orbit and determine their orbits;

(d) In situ microdebris measurement system;

(e) Development of a composite propellant tank;

(f) Space debris observation using satellite laser ranging, and the development of a general-purpose satellite laser ranging reflector.

Status

Active debris removal

JAXA has established a research programme with the aim of realizing low-cost active debris removal missions. The research and development of key technologies for active debris removal has three major themes: non-cooperative rendezvous, capture technology for non-cooperative targets and de-orbiting technology for the removal of massive intact space debris. In an effort to provide these essential key technologies, JAXA is collaborating with Japanese private companies to enable the conduct of low-cost active debris removal missions on a commercial basis.

Furthermore, JAXA has taken the lead in the Commercial Removal of Debris Demonstration (CRD2) programme. This programme consists of two phases and is aimed at executing active debris removal missions in partnership with private companies. In the first phase of the programme, the demonstration of key technologies such as non-cooperative rendezvous and proximity operation, and the inspection of the H-IIA second stage are planned for Japanese fiscal year 2023. In the second phase, the demonstration of active debris removal of the H-IIA second stage is planned after Japanese fiscal year 2026. Astroscale Japan Inc. was selected through an open competition in February 2020 as a partner company for the first phase.

Debris avoidance manoeuvres and research on space situational awareness technology

JAXA regularly receives conjunction notifications from the Combined Space Operations Center (CSpOC). In 2022, JAXA executed two debris avoidance manoeuvres for its spacecraft in low Earth orbit. As an active satellite operator, JAXA acknowledges the escalating risks of conjunction caused by space debris, in the ever-deteriorating space environment.

Core technology for space situational awareness

The Ministry of Defence and JAXA developed a space situational awareness system, which has been fully operational since April 2023. The system encompasses the following components:

(a) Radar: JAXA has engineered a new low Earth orbit radar, capable of detecting 10-cm-class objects at an altitude of 650 km;

(b) Telescopes: JAXA has refurbished its 1-m-class and 50-cm-class telescopes to increase their capability to observe space debris in high orbit, including the geostationary orbit;

(c) Analysis system: JAXA has introduced a new system to analyse observation data obtained from radar and telescope facilities. This system is instrumental in conducting risk assessments and formulating collision avoidance plans in cases where space debris is approaching JAXA satellites.

JAXA has also developed a tool to support planning for debris avoidance manoeuvres upon receiving conjunction data messages from CSpOC. Since March 2021, JAXA has made the tool available, at no cost, to all satellite operators via its website.

The tool is expected to simplify the process for debris avoidance manoeuvres and reduce the associated workload. JAXA remains committed to providing ongoing support for this initiative.

Research on technology to observe objects in low Earth orbit and geostationary orbit and determine their orbits

Generally, the observation of objects in low Earth orbit is conducted mainly by radar system, but JAXA has been working to develop an optical system to reduce the cost of both construction and operation. As a result, a large complementary metal-oxide semiconductor (CMOS) sensor for low Earth orbit observation has been developed. Analysing the data from the CMOS sensor with graphics processing unit-based image-processing technologies can help detect objects in low Earth orbit that measure 10cm or less. To increase capabilities for observing objects in low Earth orbit and geostationary orbit, two remote observation sites have been established in Australia. These additional observation sites, along with the Mount Nyukasa Observatory in Japan, will make it possible to carry out precise orbital determinations and altitude estimation of objects in low Earth orbit using the data from the sites in Australia.

In situ microdebris measurement system

The space debris monitor is an in situ microdebris sensor focusing on micro- to milli-sized debris in orbit. The most recent flight experiment was conducted by the H-II Transfer Vehicle Kounotori-5 (HTV-5). Information based on actual measurements of these small debris objects is essential to properly understand the vast amount of small debris orbiting near the Earth, especially since such debris is becoming a dominant risk factor in orbit.

The unique properties of the space debris monitor are its simple detection system, which does not need any special calibration before flight, and the potential to collaborate easily with other sensors. The space debris monitor consists of two main components: the debris detection area and the circuit areas. The debris detection area is made of very thin polyimide film equipped with thousands of 50-µm-wide conductive grid lines that can detect the diameter of collided debris ranging from 100 µm to millimetres. The size of the impacted debris is measured by detecting the number of grid lines severed when the debris impacts and penetrates the film.

JAXA is currently collaborating with the Orbital Debris Program Office of the National Aeronautics and Space Administration (NASA) of the United States of America to develop a new space debris monitor. This initiative presents the first opportunity to integrate a space debris monitor with other sensors, such as the NASA debris sensor, and will involve measurement of not only the size of the debris, but also its velocity, material and various other relevant aspects.

Development of a composite propellant tank

A propellant tank is usually made of titanium alloy, which is superior because of its light weight and good chemical compatibility with propellants. However, its melting point is so high that such a propellant tank would not demise during re-entry and would pose a risk to people on the ground.

For several years, JAXA has been working to develop an aluminium-lined, carbon composite overwrapped tank with a lower melting temperature. To gauge its feasibility, JAXA conducted fundamental tests, including a liner material aluminium compatibility test with a hydrazine propellant and an arc heating test.

Following the manufacture and testing of a shorter engineering model EM-1 tank, JAXA manufactured a full-sized EM-2 tank. The shape of the EM-2 tank is identical to that of the nominal tank, which includes a propellant management device. Using the EM-2 tank, a proof pressure test, a vibration test (for wet and dry conditions), an external leak test, a pressure cycle test and a burst pressure test were conducted, and all showed good results. Subsequently, the critical design review was completed.

Notably, the composite propellant tank offers a shorter delivery time and lower cost compared with a titanium propellant tank. Experimental and analytical evaluation of its demisability during atmospheric re-entry is ongoing.

Space debris observation using satellite laser ranging, and the development of a general-purpose satellite laser ranging reflector

JAXA has been focusing on satellite laser ranging as the third space debris observation method after radar and telescope observation. As such, the Tsukuba satellite laser ranging station began operating in June 2023.

In recent years, it has become increasingly important to improve the visibility of orbiting objects. To meet this need, JAXA has developed an affordable and compact satellite laser ranging reflector named Mt.FUJI, which can be used universally in low Earth orbit. JAXA is promoting its application internationally to improve the trackability of on-orbit objects, thereby making a meaningful contribution to the sustainable utilization of outer space.

Myanmar

[Original: English]
[6 October 2023]

A representative of Myanmar attended the UNISPACE+50 high-level segment held on 20 and 21 June 2018. Myanmar was congratulated and noted for participating in the historic anniversary of the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space, supported by the Office for Outer Space Affairs. Myanmar will remain a member of the international space community with the aim of strengthening the uses of space in achieving the Sustainable Development Goals.

As a developing country, the Government of the Republic of the Union of Myanmar has already formulated the Myanmar satellite systems MyanmarSat-1 and MyanmarSat-2, which are aimed at fulfilling the space aspirations of launching the Myanmar national satellite and gaining control over strategic national telecommunications and broadcasting services. While operating its satellite system, Myanmar will emphasize space science, technology, law and policy for the benefit of the regional and multiregional community and also contribute to the achievement of global initiatives such as the 2030 Agenda for Sustainable Development.

Since the Myanmar national satellite project MyanmarSat-3 is at the planning stage, the country has not faced the issues of space debris, nuclear power sources and related problems. Although Myanmar has not yet considered the research on those issues, it will focus on cooperation with the international community and organizations to develop and implement space debris mitigation, in view of the importance of building a secure and peaceful space environment while its own satellite system is in progress.

Slovakia

[Original: English]
[19 October 2023]

Slovak optical sensor observations of objects that are potential targets for active debris removal missions and to monitor conditions prior to re-entry

The Division of Astronomy and Astrophysics, which is part of the Faculty of Mathematics, Physics and Informatics of Comenius University in Bratislava, observes, on a regular basis, with its 0.7-m Newtonian telescope (AGO70), objects in low Earth orbit that are potential candidates for active debris removal missions, including targets such as the European Space Agency Vespa adapter. In addition, extensive campaigns have been conducted to monitor the dynamical and rotational properties of objects months and weeks before their re-entry in order to more accurately predict their demise. These efforts are supported by Slovak industry, which provides observations from its own sensor network.

Application of the Slovak all-sky meteor network for re-entry events monitoring

The Faculty of Mathematics, Physics and Informatics of Comenius University is using observations from its own All-Sky Meteor Orbit System (AMOS) network to model re-entry events. AMOS is routinely used for the automatic detection of meteors, their orbit determination and spectrum extraction. The Faculty of Mathematics, Physics and Informatics developed and is now operating a total of 23 AMOS cameras worldwide, including spectral cameras, with 7 situated in the Slovak Republic, 3 in the Canary Islands (Spain), 4 in Chile, 3 in Hawaii (United States of America), 6 in Australia and 4 recently deployed in South Africa. The AMOS network detects re-entry events, which allows the Faculty to model the trajectories of created fragments in the atmosphere and to analyse their spectral properties. A new re-entry event was captured over Slovakia in June 2023, when two AMOS cameras simultaneously detected the disintegration of the Long March 4C rocket upper stage. The analyses should lead to an improvement in knowledge of re-entry physics and an improvement in survivability predictions for fragments and on-ground population risk estimates. These efforts are supported by Slovak industry, which provides the necessary logistics and sensor interfaces and supports observation planning.

Space debris characterization through photometry and spectroscopy

The Faculty of Mathematics, Physics and Informatics of Comenius University is conducting several studies dedicated to the classification and characterization of space debris objects, in order to better understand the origins and creation mechanisms of space debris and the effects that such debris has on the night sky and light pollution. The AGO70 telescope is used to acquire light curves and phase functions of space debris. Those data are used to identify the objects' reflectance properties and their size and shape. The Faculty is investigating the application of machine learning methods to distinguish objects according to their brightness properties and to classify space objects according to their shape and surface reflectance properties. By using different spectral-type photometric filters, the Faculty is investigating the surface reflectance properties of space objects as a function of wavelength, which is directly related to material properties. AMOS spectral cameras are used to acquire specular glints and their spectra from objects in low Earth orbit. The acquired spectra provide high-resolution information about surface properties as a function of wavelength.

United Arab Emirates

[Original: English]
[29 September 2023]

The United Arab Emirates recognizes the increasing risks posed by space debris in outer space and its consequences on the sustainability and stability of the space environment and activities. Indeed, the ramifications and potential hazards would escalate significantly if space debris collided with a space object equipped with a nuclear power source.

In this regard, the United Arab Emirates recognizes the critical importance of preserving the space environment for the benefit of all nations and future generations. To this end, the United Arab Emirates has actively engaged in collaborative efforts on an international level, participating in forums and dialogues dedicated to addressing the challenges posed by space debris. The efforts include the issuance of the Space Debris Mitigation Guidelines with the aim of taking a proactive approach to reducing the generation of space debris, the tracking and monitoring of objects in orbit, and the development of protocols for debris removal.

The list below provides an overview of relevant policies, legislation and practices.

National Space Policy (2016)

In the United Arab Emirates National Space Policy, space debris was included under sustainability efforts with the objective of ensuring a secure and stable space environment that fosters the sustainability of space activities. This commitment is articulated through various platforms, including active support for both national and international initiatives focused on enhancing space debris mitigation.

Federal Law No. 12 of 2019 on the Regulation of the Space Sector

The Law is aimed at regulating the national space sector and its related activities to ensure the development of a prosperous and safe space sector. Article 1 of the law defines space debris as "A space object, or a part thereof, that no longer has a role or any purpose, including its parts or components and the resulting materials, wastes or fragments, whether in outer space, including the Earth's orbit or within the Earth's atmosphere".

Article 19 of the Law requires operators to take all necessary measures and plans to mitigate space debris and reduce its effects. Moreover, operators are required to notify the United Arab Emirates Space Agency (UESA) immediately in the event of creation of space debris, exposure to a high risk, loss of control or a collision, and of measures or plans taken to mitigate such risks. Furthermore, operators must submit to UAESA periodic reports on any warnings or risks associated with space objects that are participating in any authorized space activities.

The full document is available at https://space.gov.ae/Documents/PublicationPDFFiles/POLREG/SpaceSectorFederalLaw_EN.pdf.

Space Debris Mitigation Guidelines (2022)

The United Arab Emirates has recently issued the Space Debris Mitigation Guidelines. The main objective of the Guidelines is to protect the environment and the sustainability of space activities by encouraging the mitigation of new space debris generation.

The Guidelines require operators to submit a space debris mitigation plan that takes into consideration international standards and best practices such as ISO 24113:2011: Space systems - Space debris mitigation requirements, the Space Debris Mitigation Guidelines of the Inter-Agency Space Debris Coordination Committee and the Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space.

Operators are also required to carry out risk assessments and submit implementation plans. In addition, operators must notify UAESA immediately of the end of the functional use of a space object, its disposal or re-entry, an accident or incident involving a space object and the creation of space debris by a space object. Furthermore, the Guidelines provide a set of recommendations for space debris mitigation measures that operators can apply.

The full document is available at https://space.gov.ae/Documents/PublicationPDFFiles/POLREG/SpaceDebrisMitigationGuidelines-EN.pdf.

Nuclear power

With reference to the National Space Law, article 17 highlights that operators are required to obtain authorization from UAESA to use nuclear power sources, and must immediately inform UAESA about any accident or incident that occurs, the risks faced, and any measures taken to reduce them or their effects.

It is also noted that any nuclear use will not be authorized in collaboration with the Federal Authority for Nuclear Regulations.